

## Ecosystem-based fisheries management: the carrot or the stick?

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In the last few years, a series of papers have been published in high-profile scientific journals describing the role of fishing in the collapse of marine ecosystems (Jackson et al. 2001, Myers & Worm 2003), the destruction of marine habitat (Watling & Norse 1998) and changes in ecosystems that are possible precursors to future collapse (Pauly et al. 1998). The central theme of this 'Litany' is that conventional single species fisheries management has failed and new approaches are needed. A major element of the proposed new approaches is a move from conventional single-species management to 'ecosystem-based management' (NRC 1998). The specific proposed solutions that emerge from the Litany include (1) elimination of subsidies for fishing fleets, (2) reduction of target fishing mortalities, (3) protecting a significant portion (20 to 30%) of the world's marine areas from fishing in the form of Marine Protected Areas (MPAs) (Pauly et al. 2002), and (4) elimination of destructive fishing practices (bottom trawling). These approaches require a powerful centralized government and are, therefore, unlikely to be implemented in most of the developing world.

While papers subscribing to the Litany seem to have near exclusive access to the pages of the most prestigious journals, their conclusions are strongly contested within the scientific community. For example, the contention that the predatory fishes of the ocean have

declined by 90% (Myers & Worm 2003) and, by implication, that these fisheries have collapsed, has been challenged on both the technical nature of the analysis of fishermen's catch records (Walters 2003) and detailed analysis of the fisheries ([www.soest.hawaii.edu/PFRP/large\\_pelagic\\_predators.html](http://www.soest.hawaii.edu/PFRP/large_pelagic_predators.html)). More simply, the catch data from these fisheries show that they are providing increasing yields, quite contrary to what one would expect from fisheries that Myers & Worm (2003) classify as having collapsed 20 to 30 years ago.

The contention that MPAs would significantly benefit fisheries yields is equally contested (Norse et al. 2003, Hilborn et al. 2004). Nevertheless, the Litany has dominated public perception of fisheries problems and other authors citing the Litany frequently say that 70% of the world's fish resources are overexploited or collapsed, rather than fully exploited, overexploited or collapsed. For example, 'According to various official reports, *three-quarters* of the world's fish stocks *have been depleted*. Official statistics may well err on the conservative side: overall catches are declining, yet illegal fishing is increasing. The net result is a crisis for natural fisheries.' (O'Riordan 2003). In fact, most of the world's fisheries are not overexploited and continue to be quite productive (FAO 2002a). Within the U.S., only about 16% of potential yield is being lost due to over-fishing (Hilborn et al. 2003).

The scientific objections to the Litany are primarily a matter of degree. No one questions that the majority of the world's fisheries are heavily used, many are over-fished, some have collapsed, and good biological and economic management suggests substantial reductions in fishing pressure are needed for sustainable management (Hilborn et al. 2003). The major disagreements

over possible solutions are not so much where we would like to be, but how to get there. The form of ecosystem management that emerges from the Litany is one that concentrates on the ecosystem in which the fish are embedded and relies on strong central government control. I, and others (Garcia et al. 2003, Sissenwine & Mace 2003), believe that we need a form of ecosystem management that emphasizes the interaction between fish, fishermen and government regulators and concentrates on incentives and participation with user groups. This difference can be considered as a choice between a participatory approach with incentives as a 'carrot', and a centralized government using regulations as a 'stick'.

The key elements of the current fisheries management approach used in most regulated fisheries in developed countries and international agencies include (1) single species stock assessment to calculate the Maximum Sustainable Yield (MSY) for each stock, (2) a political process to set regulations that determine allowable time, area, gear and catch limits that intertwines allocation between users and conservation, (3) regulation on large spatial scales, (4) a centralized management structure for science, decision making and enforcement with costs paid by governments, and (5) involvement of stakeholders primarily through the political or legal process. It should be noted that most stocks world-wide are not managed in any meaningful way, and any proposals for management, ecosystem or otherwise, need to be achievable. To argue that we need more data-intensive management and more regulation by central governments in the fisheries of the world that have little data and little regulation is untenable.

There have been a wide range of papers dealing

with ecosystem management and each of these has a distinct flavor. The 'ecosystem management' I describe here shares elements with the views of others, all of whom emphasize various forms of marine tenure and the dynamics of fishing fleets and regulators. The primary difference between the incentives approach and the forms of ecosystem management emerging from the Litany is governance. The solutions proposed by the Litany rely on strong top-down control to determine objectives and management actions and to assure compliance by fishing industries. The incentives approach recognizes that fisheries are dynamic systems comprised of people and fish (Harris 1998), that top-down control is highly limited in most fisheries, and that good outcomes result from creating incentives that make the interest of the participants in the fishery consistent with the interest of society as a whole. What has failed in conventional fisheries management is not single-species management, but the top-down control as conventionally practiced. In most of the world's fisheries, the commercial and recreational fishermen have significant political power and, hence, attempts to impose regulations that are contrary to their economic interests will most likely fail. Ecosystem management that relies on top-down control for implementation, and makes no allowances for the social/political dynamics of the regulatory structure, is no more likely to succeed than conventional single species management.

What is missing from the conventional single species fisheries management approach is (1) a form of marine tenure—where individuals or groups of fishermen are guaranteed a specific share of future catch—for users that reconciles their economic interest with long-term conservation, eliminates the race-for-fish, and reduces

or eliminates incentives for overcapitalization of fishing fleets, (2) recognition that MSY is a poor fisheries management objective and that economic and biological outcomes are better when catches are below MSY and stock sizes consequently higher, (3) direct involvement of stakeholders in data collection, data analysis, and decision making, (4) setting the spatial scale of the data collection, science, and management appropriate to the spatial scales of the fish and the fishermen, and (5) management agencies that explicitly strive for harvesting capacity to match the long-term productive capacity of the resource.

The central theme of this paper is that, by considering humans in ecosystem management, we recognize that appropriate incentives can stop the race-for-fish and eliminate or reduce most of the current problems in fisheries management. In the sections below I explore the nature of incentives, and how incentives interact with other aspects of fisheries management including MSY, institutional structure, and single species management.

**Incentives.** When there is a race-for-fish, fishermen increase their incomes by fishing harder, building bigger boats and catching fish before someone else does. There is no individual economic incentive for conservation. With various forms of marine tenure, conservation of the resource is in the individual fisher's economic interest. The strongest form of tenure is resource ownership, which is the oldest form of fisheries management in much of the world, found in community control of fishing grounds in the western Pacific (Johannes 2002) and now used as the primary management system in Chilean artisanal fisheries (Castilla & Fernández 1998). A different form of ownership

is allocation of fishing rights by the state through high access fees or auction as is practiced in the Falk-land Islands (Barton 2002) and in Washington State for management of geoduck. This contrasts with conventional management in which the state gives away the rights to fish and then uses tax revenue to manage the fishery. When high access fees are charged, the state has both the incentive and the revenue to implement stringent top-down control. Tenure granted to cooperatives is another mechanism to stop the race-for-fish since it allows the cooperatives to concentrate on economic maximization of yield from the fishery. Coops have been implemented for hake and pollock on the west coast of the U.S., for salmon in the Chignik area of Alaska, and for several fisheries in Mexico. The most broadly used form of marine tenure is individual quotas in which a specific portion of the total catch is allocated to individuals or vessels. Individual Transferable Quotas (ITQs), under which individuals can catch and/or sell their right to catch a portion of the total allowable catch, have now been implemented in New Zealand, Australia, Iceland and several specific fisheries within the U.S. and Canada. ITQs, like other forms of marine tenure, provide incentives to reduce fishing capacity to a level appropriate for productive capacity of the resource and to concentrate on minimizing costs and maximizing value of the catch, since the total catch is determined by a science-based public process (NRC 1999a).

**Single species management.** A major element in the Litany is a list of fisheries collapses that includes the sea otter, the great whales, the northern cod, and bluefin tuna (NRC 1999). In fact, none of these really illustrate that single species management cannot work.

Rather, they are examples of failures to do single species management properly, since the stocks were generally fished down to less than 1% of their original biomass—far below single species guidelines of 25 to 50%. Sea otter, great whales and bluefin tuna were largely unregulated and highly valuable. The natural outcome was to move to the bio-economic equilibrium which is near extinction. For these stocks, single species management did not fail, it wasn't practiced. In northern cod, the scientific/political system failed (Harris 1998). While ecosystem changes may have resulted from the severe depletion of these stocks, these changes would likely not have happened had the stocks been maintained at the abundances called for under conventional single species management. Thus, this list of fisheries failures suggests that the problem was poor implementation of single species management rather than a need to move beyond it.

**MSY.** MSY emerged in the 1950s as the default management objective within fisheries science. However, by the mid-1970s it had been largely discredited among scientists who recognized that maximizing the tons of fish landed was unlikely to be the appropriate goal of fisheries management (Larkin 1977). Yet, beginning with the Law of the Sea, and later through national legislation in many countries, MSY became firmly enshrined as the default objective of fisheries management. The result is that management agencies now try to determine the maximum yield that could possibly be obtained from a fish stock, and regulatory agencies try to set catch limits at the maximum that could be harvested. This ignores the fact that the economic optimum is almost always at yields lower than the MSY, and involves less fishing pressure. Once the race-for-fish is eliminated, the fishing industry

recognizes that it is better served by higher stock size and, consequently, higher catch-per-hour fished as well as lower, but more stable catches. MSY is often incompatible with economically viable fisheries.

### **Political decision making and stakeholder involvement.**

The track record of most fisheries management agencies is not good, and this failure has often been blamed on the participation of self-interested stakeholders in the decision-making process. This has led to frequent calls for 'science based management,' in particular for the elimination of commercial and recreational fishermen from the decision making process. I argue that the major problem with political decision making as commonly practiced is that the allocation between competing groups (nations, gear types, communities) and the questions of conservation and sustainability are not distinguished. As most fisheries involve individuals or groups competing for a share of the fish, the agencies often spend almost all their energy on allocation between competing users. Once the race-for-fish is replaced by some form of tenure, representatives of fishing groups will become an interest group with a high vested interest in making decisions that will allow for the long-term sustained use of the resource. With appropriate incentives, commercial fishing groups have often called for lower catches, have engaged in data collection and analysis, and have often even funded the majority of the scientific advising process.

**Ecosystem management of fish and fleets.** The important elements in incentive-based ecosystem management are fishing fleets and fish, rather than fish and their ecosystem. The dynamics of investment, fish harvesting, markets, and the incentives for fishermen



to conserve fish are, the most important considerations for sustainability. The trophic interactions between species, the dynamics of marine ecosystems, or the scientific approach applied in determining quota recommendations are secondary considerations. Following from this, ecosystem management should have the following characteristics: (1) incentives in the form of marine tenure will be in place so that the long-term economic and social benefits of all participants will be maximized by sustainable fishing practices; (2) data collection, analysis, setting regulations, and enforcement, will be on the spatial scale appropriate to the biology of the fish and the structure of the fishing communities; (3) stakeholders will be intensively involved in all levels of science, management and enforcement, and under some circumstances fishing groups will have complete control over the resource; (4) all costs of research, management and enforcement will be paid by user groups; (5) the primary role of central governments will be to audit the system to assure that the biology and economics of the fishery are sustained and to ensure that national/international agreements and laws are respected and enforced; and (6) substantial portions of the marine ecosystem will be protected from fishing activity to provide biodiversity reserves and reference sites (in the sense of an unexploited control group).

The Pew Oceans Commission identified governance structure as the key failing in U.S. fisheries policy (Pew Oceans Commission 2003), and recognized the need to separate allocation from conservation decisions. However, this commission did not see a significant role for incentives. Rather, it recommended strong, centralized, top-down control. The top-down approach contrasts with the incentives approach in that the former often

views the exploiters of marine resources as natural destroyers of marine environments who need to be excluded from decision making as much as possible, while the latter views them as necessary partners in achieving good management.

**Where economic incentives are not enough.** The strict economic incentives associated with marine tenure will not protect all ecosystem components from the effects of fishing. For example the following topics would still need to be addressed: (1) unproductive species in mixed species fisheries; (2) by-catch of threatened or endangered species; (3) trophic impacts of fishing; (4) habitat impacts of fishing; (5) long-lived species where the economic optimum is depletion; and (6) where international jurisdictions makes granting tenure difficult or impossible. The economic return to tenure holders is not increased by avoiding these problems and here I see governmental agencies having an important auditing role. Consider a theoretical example in which some group had been granted ownership and management rights to fishing grounds. The tenure holder should be required to develop a management plan associated with the areas of concern listed above, that would include monitoring, evaluation and enforcement. The management plan might involve mandatory by-catch quotas, gear modifications to avoid non-target species, prohibition of destructive fishing gears, or overall catch quotas on some non-target species. For many fisheries, this may require intensive, perhaps complete, observer coverage. While this is very expensive, it may well be the true real cost of achieving economically sustainable fisheries that meet society's goal to protect biodiversity. Alternatives might include expanding protected areas as reserves for by-catch species that would then be unprotected in

the exploited areas. Incentives have an important role to play because the higher the market value of a specific form of tenure is, the more important it is to the tenure holder not to have the tenure revoked due to violation of regulations.

By offering user groups marine tenure that gives them much more direct control of their own destiny, and of a highly valuable asset, governments have been able to obtain agreements with fishing groups to accept and maintain industry funding of the costs of fisheries research and management (Australia, New Zealand, Iceland, Chile) as well as intrusive and expensive observer coverage. I am not advocating ITQs, and the usual allocation based on catch histories, as the primary form of tenure. There are many other forms of tenure that would achieve the desired goals, among them state ownership with high access fees and cooperatives. However, to achieve a politically viable transition from our current system to a tenure system something has to be offered to the fishermen. The obvious solution is a significant portion of the future catching rights in the form of ITQs, with the remainder owned and leased by the state.

**Summary.** Ecosystem management means different things to different authors. I present here my vision of the key elements of such an approach. The emphasis on institutions and the evolution of current single species management approaches is consistent with many others, but differs greatly from the ‘revolutionary’ change called for in response to the perceived failure of single species management. I see the failures of fisheries management as being due to a failure to recognize the importance of people and people management, not due to single species management. I support

the view of ecosystem management that recognizes the institutional dynamics between harvesters, managers and scientists, and stops the race-for-fish and overcapitalization through incentives rather than stopping overfishing through centralized top-down control.

I share with the papers of the Litany a common vision of the world's fisheries that have smaller fishing fleets, higher stock biomasses and significant areas protected from fishing. However, I see a very different way to achieve these goals. In my vision incentives are key, fishermen are involved in all aspects of management, and they also pay for the annual costs of fisheries management.

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